# Design Build Materials White Papers

CONTENTS

# DESIGN-BUILD
# 10.00
# QUALITY INCENTIVES, PERFORMANCE INCENTIVES, WARRANTIES AND STATISTICAL ACCEPTANCE

Design Build offers opportunities as well as pitfalls for producing a quality project. Four separate but united strategies are necessary to ensure quality: quality incentives, performance incentives, warranties and statistical acceptance. Why have all four areas? These methods are synergistic without duplicating efforts. New pavement might require a quality incentive (for longitudinal physical segregation), a performance incentive (for smoothness), a warrantee (for rutting and friction). No single combination of these tools can provide a full measure of assurance of final quality.

**Quality Incentives:**

These are owner-controlled incentives implemented to drive the DB to perform quality work. Part of the incentive will be objective, but part of the incentive, by its nature, will be subjective. Being fined for non-compliance with environmental permits would be a clear objective performance failure. Having non-compliance without fines may be subjective but still important.

Quality incentives are a tool to drive the DB toward correcting quality failures. A DB might choose to place concrete that has gone beyond its allowable pour time, but they might think twice about doing so if they know it would jeopardize a sizable monthly quality incentive.

**Performance Incentives**

Performance incentives reward superior performance for very specific performance measures. An example would be providing a monetary incentive for pavement smoothness – the smoother the DB paves, beyond a certain threshold, the greater the monetary incentive. Work that lends itself to performance incentives is work for which objective, quantifiable performance measures already exist. Pavement smoothness is one of the best examples of an existing performance measure that is easily quantifiable and can be objectively measured.

**Warranties**

Warranties require the DB to ensure quality for a set period of time after completion of the project. Warranties protect against failures that can occur over relatively short time frames (3-5 years) that cannot be predicted from traditional measures of construction quality. For example, initial smoothness does not guarantee continued smoothness over the first 3-5 years of pavement life. On design build projects we transfer both the design and the construction quality acceptance to the DB firm. The performance risks are all under the control of the DB. The owner is at risk for failures that can occur after completion of the project, particularly for failures that cannot be predicted from existing quality acceptance testing and inspection. Warranties work with, not against, quality incentives and performance incentives.

Some examples are in order to consider the functioning of warranties and pavements are a good place to start. On a DB project, the DB firm designs the pavement structure and designs the pavement mix design. The DB firm then builds the pavement and does the acceptance testing during construction, with the owner doing auditing and verification testing. Is it possible to build a pavement under these conditions and have catastrophic failure in the first 3-5 years? Absolutely. On concrete pavement, late sawing can cause mid-panel cracking that might not show up until well after completion of the project. Concrete pavements can also have early failures due to poor dowel bar placement. Asphalt pavements can look perfect upon completion, but can ravel, rut, strip or lose friction within the first 3-5 years. We do not yet have the perfect predictive performance tests for either concrete or asphalt pavements to give use complete assurance we will not have early performance failures.

Are these early performance failures within the contractor's realm of control? Again, absolutely. Contractors control sawcutting on Portland Cement Concrete pavements, just like they control the compaction on Hot Mix Asphalt pavements.

## Statistical Acceptance

For maintaining quality on items of work that will have significant numbers of materials tests, statistical acceptance is the preferred process. When manufacturing large quantities of materials (such as HMA), it is expected that the material will have properties following a normal distribution. Statistical acceptance balances the two prime risks: owner's risk and contractor's risk. The owner's risk is accepting material when it does not meet specification; the contractor's risk is having material rejected for failing to meet specification when it actually does meet spec. Using statistical acceptance is an advantage for both the owner and the contractor, in that it focuses on maintaining quality on a large scale manufacturing process, rather than focusing on any given single test. Statsitical acceptance, and statistical process control, allows for variation in sampling, testging and materials properties while providing for the quality of the entire lot of material produced.

Candidates for statistical acceptance include HMA and unbound aggregates.

# DESIGN-BUILD
# 10.00
# MATERIALS TESTING QUALITY PROGRAM

**Policy**

The quality of materials and methods of construction are essential to achieving an end product that provides the maximum benefit to the public. A proper approach for materials sampling and testing is essential in securing reimbursement of funds from FHWA, and insuring to the taxpayers of the State of Washington that their money is being spent appropriately. This process meets the FHWA requirements found in the Code of Federal Regulations, CFR 637.205, for allowing contractor sampling and testing to be used for acceptance. Following is a summary of the process for construction materials quality management for design-build contracts.

The Design Builder will monitor and measure the characteristics of all work activities to verify that all project requirements have been met. This monitoring and measurement will be carried out at appropriate stages of construction in accordance with the planned work and minimum frequencies for sampling and testing.

The Design Builders Quality Assurance test data will be used for acceptance provided it can be statically verified by the WSDOT's Quality Verification test data. In the event of test result discrepancies between WSDOT and the Design Builder where resolution cannot be resolved, the Quality Assurance Team shall determine the test data to be used for acceptance.

There are essentially five levels of quality management provided on construction projects administered by state highway agencies where contractor testing is being used for acceptance. These levels include:

> **Quality Control (QC):** The Construction Design Build Contractor will be responsible for Quality Control; defined as activities performed by the contractor, the producer or the manufacturer to ensure that a product meets the requirements of the contract. Components of QC may include checking materials handling and construction procedures, calibration and maintenance of equipment, production process control, and any sampling and testing done for these purposes.
>
> **Quality Assurance (QA):** The Design Builders Construction QA Manager will be responsible for the performing of all QA materials sampling and testing. QA testing encompasses all those planned and systematic actions necessary to ensure that all materials incorporated in the work meet the requirements for the material being used, and will perform satisfactorily for the purpose(s) intended. All QA materials sampling and testing will be used for acceptance and performed by a statistically valid, random sampling method, utilizing testing methods and minimum frequencies defined in the WSDOT Construction Manual, the Materials Manuals, or in accordance with WSDOT/Design Builder agreement.

**Quality Verification (QV):** Materials Quality Verification will be performed by WSDOT, or it's agent, to validate the design builders sampling and testing QA program. All verification sampling and testing will be performed by a statistically valid, random sampling method, utilizing testing methods defined in the WSDOT Construction Manual, the Materials Manuals, or in accordance with WSDOT/Design Builder agreement. The testing rate typically will be at one (1) verification test to every five (5) of the design builder's acceptance testing. More frequent testing during initial startup may be necessary to verify the process is under control. When QV and QA results do not compare or have wide variances, additional testing may be needed to validate the results.

**Independent Assurance (IA):** The IA activity is an independent verification performed by WSDOT and is an observation of all sampling and testing procedures, reviews of the qualifications of the tester and verification of the testing equipment used to perform acceptance testing activities. This program will validate both the design builder QA processes and the WSDOT QV processes. This work includes auditing acceptance testing records, observing DB technician testing, taking a split samples on a randomly sampled basis and checking verification of DB testing equipment.

**Quality spot checks:** Non-scheduled spot checks of work performed by WSDOT representative. This sampling and testing effort is not scheduled and is performed solely for the benefit of the owner.

**Discussion**

The state allows the use of contractor testing provided it is verified by testing from the state. This meets the requirements that have been set in the Code of Federal Regulations. This program as defined above allows for the Design Builder QA test data to be used for acceptance. With our verification testing and independent assurance, we ensure confidence that the Design Builder's testing has been performed correctly and reflects the true quality of the final product.

# DESIGN-BUILD
# 11.00
# MATERIALS TESTING LABORATORIES

## Policy

An approved laboratory reporting directly to the Design Builder's Construction QA Manager will be acceptable to perform QA testing. The Design Builder, or a sub contractor, may employ the laboratory personnel. The laboratory shall meet the requirements of AASHTO R-18 for qualified testers and calibrated/verified equipment and be able to accomplish the testing according to the test procedure they are performing.

WSDOT approval of the laboratory will be required. WSDOT will perform an on-site evaluation of the facility to ensure all work is being performed according to the contract standards. The evaluation includes both audit and inspection functions, including reviewing training records, reviewing equipment calibration and verification records, and witnessing testers performing the test procedures.

The laboratory shall be properly equipped, staffed, and fully operational for WSDOT inspection a minimum of 10 days prior to start of work. The Design Builder will be advised in writing of any deficiencies noted during WSDOT inspection and must take immediate action to correct the noted deficiencies. Work will not be permitted to proceed until the laboratory and staff is inspected and has received written approval from the WSDOT Materials Engineer.

At a minimum for all DB contracts, the test equipment for the following test procedures shall be as shown so that proper correlation between the QA and QV test results may be established.

- WSDOT FOP for AASHTO T308 Asphalt Content by Ignition Method (Barnstead Thermolyne Model F85938 or other approved ignition furnace with internal balance).
- AASHTO T-310 and WAQTC TM8 In-place Densities by Nuclear Method (Troxler 3430 Series Moisture/Density Gauge)

## Discussion

When contractor's testing is used for acceptance, WSDOT requires the contractor's laboratory to be qualified.

An AASHTO accredited laboratory can be used for testing; however AASHTO does not offer accreditation in all testing that is expected to be performed on future projects (including testing for field densities, or other tests that are not listed in AASHTO standards). WSDOT must perform inspections of the DB laboratory to ensure that the DB firm is using qualified testers and verified equipment.

# DESIGN-BUILD
# 12.00
# MATERIALS TESTING PERSONNEL

**Policy**

The Design Builder shall have a qualified Construction QA Manager to oversee all sampling and testing operations. This person shall be responsibility for insuring that qualified testers are performing all testing according to the proper test procedure, and using calibrated and verified testing equipment.

The Design Builder shall have all acceptance testing performed by qualified testers. The testers shall by qualified as defined in the requirements in AASHTO R-18. A testing technician currently qualified in concrete testing by the American Concrete Institute (ACI) (Level I) will be considered qualified. The qualifications of the laboratory technicians employed by an AASHTO Accreditation Program (AAP) will be accepted for AASHTO test methods only when confirmed by the laboratory's training and evaluation records. The competency of the tester shall be re-evaluated at least annually in all tests they perform.

The testing technicians performing the field and laboratory sampling and testing shall be employed by the Design-Builder or subcontractor laboratory and supervised by the Construction QA Manager.

WSDOT's independent assurance inspector will perform an independent verification and observation of all sampling and testing procedures, including taking and testing split samples, and a review of the qualifications of the tester.

**Discussion**

If contractor testing is to be used for acceptance, WSDOT must meet the Federal requirements under CFR 637.205. These requirements include that all testing staff are qualified in the testing procedures they perform and all tests must be performed with calibrated and verified testing equipment.

An AASHTO accredited laboratory can be used for testing; however, AASHTO does not offer accreditation in all testing that may be performed, such as field densities and other non-AASHTO/non-ASTM tests. Testers therefore must be qualified in all tests whether they are AASHTO, ASTM, WSDOT, WAQTC or other test methods.

# DESIGN BUILD
# 13.00
# MATERIALS TESTING FREQUENCIES
# AND
# RANDOM SAMPLING PROGRAM

## Policy

Materials Quality Assurance (QA), sampling and testing frequency will be performed in accordance with the WSDOT Construction Manual, Materials Manuals, Standard Specifications, or other contract provisions defined in the design build agreement.

Materials Quality Verification, (QV), sampling and testing will typically be performed at a rate of one (1) verification test to every five (5) of the design builder's acceptance testing. During production startup testing may be required on a more frequent basis until the process is established to be under good control. When QV testing reaches 25 samples, and the QA and QV testing can be statically validated, the frequency of the QV tests can be reduced to 1 in 20. If at any time the QA and QV testing can not be validated, then the QV testing frequency shall be reduced to 1 in 5 until 25 samples are reached again with satisfactory statistical validation.

For all materials that are not addressed by WSDOT standards, material testing specifications, testing procedures, and frequencies will be determined by the Materials Quality Assurance Team with concurrence of the Design Engineer of Record.

All acceptance and verification sampling and testing shall be randomly obtained, at the location and frequency stated in the contract documents. The Design-Builder shall provide to WSDOT a testing plan for each material. The testing plan shall be developed using a Random Numbers Table and reflect the proposed total project quantity. The testing plan shall be submitted prior to the beginning of production or placement of the material.

When small quantities of materials are to be used, they can be accepted without sampling and testing when the quantity of materials proposed for use by the Design Builder are less than the minimum sampling and testing frequencies. Structural Concrete will not be considered under the small quantity definition. The Engineer of Record shall follow the procedure for acceptance of small quantities found in Chapter 9-5.2 of the construction manual.

## Discussion

Following CFR 637.205, WSDOT requires a quality assurance program be developed, identifying the frequency for sampling and testing, specifying the location for sampling and testing, and identifying of any specific attributes to be tested.  Sampling and testing must follow a statistically valid random sampling protocol.

To satisfy statistical evaluation protocols, QV sampling and testing early in the project may be performed more frequently, until a valid statistical sample has been obtained.  Once a statistically valid sample is present, QV sampling and testing can be reduced.

# DESIGN BUILD
# 15.00
# QC/QA PLAN REQUIREMENTS

**Policy**

The Design-Builder shall be responsible for the quality of construction and materials incorporated into the project. The Design-Builder's Quality Assurance measures are to insure that operational techniques and activities provide material of acceptable quality. Design-Builder sampling and testing shall be performed to control the processes and determine the degree of material compliance with the Contract Provisions.

The Design-Build QC/QA Plan shall include a description of the process for quality control, which shall be defined as a separate entity from the QA organization. The construction design-builder, their supplier, or subcontractor shall perform the project quality control (QC), to provide process control for design, construction and materials being produced for use on this project

The quality assurance (QA) organization(s) and personnel shall have sufficient authority and organizational autonomy to identify quality problems, and to initiate, recommend, and verify implementation of solutions. Persons performing Quality Assurance functions shall be at an organizational level that ensures that they are not influenced by the impact of implementation of the Quality Assurance measures on the Project schedule, performance or cost. To ensure the above organizational independence, at the very least, the Construction QA Manager and his staff shall not work under the direction of the Construction Superintendent for the project and should work directly for the Design Builders Project Manager. All key personnel performing Quality Assurance functions shall be exclusively designated to such and shall not be assigned to perform conflicting duties.

The plan must at a minimum address the following:

A. Describe the Design-Builder's quality assurance organization, including the number of full-time equivalent employees with specific Quality Assurance responsibilities and including a chart showing lines of authority and reporting responsibilities;

B. List by discipline the name, qualifications, duties, responsibilities and authorities for all persons proposed to be responsible for Construction Quality Assurance;

C. Quality assurance sampling, testing, and analysis plan with frequencies, location and methods;

D. Load testing and integrity testing required to verify adequacy of the foundation capacity, soil reinforcement elements, or adequacy of ground stabilization;

E. Identify properly equipped, staffed, and fully operational laboratory(s) to be used

F. Specify documentation for QA activities, including control charts; and

G. WSDOT requirements for corrective action when quality acceptance criteria are not met.

H. Identify activity meetings that include discussions relating to what materials will be used, how the work will be accomplished, by whom it will be performed, and where, when, and how the work will be done.

The Contract Provisions may also require specific quality assurance measures for certain materials. When so required the Design-Builder shall provide all personnel, equipment, supplies, and facilities necessary to perform quality assurance, obtain samples, and perform tests required in the Contract Provisions.

# DESIGN BUILD
# 20.00
# MATERIALS QUALITY ANALYSIS PROGRAM

**Policy**

The Design-Builder QA sampling and testing results may be used for acceptance provided that they are validated by WSDOT's verification sampling and testing (QV).

Both the Design Builder QA and the WSDOT's QV test data will be recorded in a joint database that has been set up to statistically evaluate the test data to determine the acceptability of the material tested. This evaluation will be performed by using the F and t Test analysis as described in AASHTO Report Titled "Implementation Manual for Quality Assurance", Appendix F, dated February 1996, or other similar F and t Test analysis. The Construction QA Manager shall be responsible for performing the evaluation. Any test data that is found to be outside the normal F and t distribution will have to be reviewed by the Quality Assurance Team and a determination be made to why the test data is outside the normal distribution.

The Quality Assurance Team shall make cooperative effort by the Design-Builder and WSDOT to identify the cause of discrepancies in test results. A report will need to be generated defining what the problem was, the cause of the problem, and the solution to prevent the problem from happening again. As a minimum, the review should include the following actions:

- A check of test data, calculations and results;
- Observation of the sampling and testing by the Independent Assurance Inspector;
- Check of test equipment by the Independent Assurance Inspector.

If the Quality Assurance Team fails to identify the cause of discrepancies in test results, then the DOT's test results shall be used for acceptance.

When certain attributes of a material are not statistically evaluated for acceptance, such as concrete slump, entrained air content, and temperature for concrete, and the differences between the Design-Builder's test results and verification test results exceed the values for precision and bias as found in the testing procedure, placement of the material shall be halted until the Design-Builder can demonstrate that the material is within the required specifications.

**Discussion**

If contractor testing is to be used for acceptance, WSDOT must meet the Federal requirements under CFR 637.205. These requirements include that all testing staff are qualified in the testing procedures they perform and all tests must be performed with calibrated and verified testing equipment.

# Design Build
# 22.00
# Materials Quality Incentive Program
# For Hot Mix Asphalt

**Policy**

The quality incentive for Design Build projects will be full pay for all acceptable materials. The Design-Builder QA test results for Hot Mix Asphalt (HMA) and aggregate shall be statistically evaluated for quality level and price adjustment, if applicable, in accordance with this section 1-06 of the Standard Specifications. The maximum allowable Composite Pay Factor (CPF) for materials accepted under this section shall be limited to a maximum of 1.00.

Acceptance of materials shall be based on statistical evaluation for the applicable elements such as gradation, fracture, sand equivalent, asphalt content, optimum moisture, etc. The Design-Builder shall use WSDOT's QA software that can be downloaded from the WSDOT web site or another software program that is mutually acceptable. The material shall be sampled at the point of acceptance in accordance with the applicable test procedure and specifications. A table of adjustment factors and the price for the material needs will need to be added to the contract documents.

The general special provisions for statistical pay for aggregate will need to be added to the contract requirements.

After the first three sublots have been tested the Design Builder shall compute and maintain the Composite Pay Factor (CPF) of the completed sublots. The Design-Builder shall furnish WSDOT with a copy of the results of all Quality Assurance testing and the composite pay factor calculations within 24 hours of completing the testing or the next day of business.

**Discussion**

This process should provide WSDOT with specification material. This procedure is currently in place and works well with the materials WSDOT purchases on construction projects with the normal design-bid-build process.

# Design Build
# 23.00
# Materials Quality Assurance Team

## Policy

The Design Builder and WSDOT will jointly form and participate in a Materials Quality Assurance Team. The Design Builder's Construction QA Manager will be responsible for setting the meeting schedule, agenda, and documenting the meeting attendees and minutes. The meetings will be held as needed to address all quality issues on the project. It is suggested that meetings occur every few weeks or oftener if necessary.

The purpose of the meetings will be to discuss any issues of poor quality, processes that are unstable or out of good control, evaluation of disagreement between QA and QV test data, future quality concerns, and any issues that WSDOT or the Design Builder may have about the materials quality of the project.

It is recommended that the Design Builder designate to the Materials Quality Assurance Team their personnel in charge of QC and QA, superintendents, and others who have quality concerns. It is recommended that the DOT designate to the Materials Quality Assurance Team our project manager, project engineer, field engineers, FHWA, and others who have quality concerns.

## Discussion

This concept has been used on other projects and has worked very well to provide a good line of communication, resolve issues in a very timely manner, and look ahead for other quality issues that might be coming up. WSDOT may consider asking knowledgeable FHWA personnel to attend the team meetings.

# Design Build
# 30.00
# Materials Approval and Acceptance Program

## Policy

The Design Builder will be responsible for all materials approvals and acceptance by means of testing, inspection, and documentation. A Materials Certification package as defined in the Construction Manual chapter 9-1, approved by the Design Builder's Construction QA Manager, shall be submitted to WSDOT prior to acceptance of the project.

**Materials Approval –** All materials shall be reviewed and approved by the Construction QA Manager prior to use. The Design-Builder may use the Qualified Product List (QPL), may submit a Request for Approval of Materials (RAM), or may denote approval by listing the material in the plans and specification that has been signed and PE stamped by the Engineer of Record.

**Qualified Products List (QPL) –** The Design-Builder may use products listed on the latest edition of WSDOT's Qualified Product List (QPL) without submitting a Request for Approval of Materials (RAM) to the Construction QA Manager. The Design-Builder shall follow the acceptance requirements as listed in the QPL for the product/material used.

**Request for Approval of Material (RAM) -** The RAM shall be used when the Design-Builder elects not to use the QPL or the material is not listed in the QPL or not shown on the PE stamped plans and specifications. The RAM shall be prepared by the Design-Builder and submitted to the Construction QA Manager for approval before the material is incorporated into the work. Approval of the material does not constitute acceptance of the material for incorporation into the work.

**Materials Tracking System –** The Design Builder will develop a materials tracking system to track the quantities of material placed and the acceptance status. This will be kept up to date and posted in a location on the job site where the WSDOT can monitor it.

**Aggregate Source Approval –** The Design Builder can use any approved aggregate that is included in the WSDOT Aggregate Source Approval System. If the Design Builder wishes to use an aggregate source that is not on the WSDOT Aggregate Source Approval System, preliminary samples will have to be evaluated for the quality, including degradation and LA Abrasion tests, in addition to the acceptance testing. In addition to the QA testing, QV samples will be taken for concurrence of quality.

**Materials Acceptance –** All material that the Design Builder wishes to use shall be tested, field verified, and or documented. All materials have to be approved prior to use. The materials acceptance program shall be as defined in the WSDOT Construction Manual, Materials Manuals, Standard Specifications, or other contract provisions defined in the design build agreement.

**Visual Inspection –** The acceptance of certain types of materials may be based on visual inspection prior to incorporating the materials into the project. Product documentation shall be provided in the form of a manufacturer's catalog cut or product data sheets. For details regarding specific instructions for field acceptance see Chapter 9-4 of the WSDOT Construction Manual.

**Certificate of Compliance –** The acceptance of certain types of materials shall be based on receipt of a Certificate of Compliance prior to incorporating the materials into the project. This process is intended to speed the materials approval process and insure the correct material is being used on the project. The Certificate of Compliance shall meet the requirements of Section 1-06.3 of the Standard Specifications.

**Certificate of Materials Origin** – A Certificate of Materials Origin (CMO) will be required for all steel and iron products if there is federal participation on this project, under the federal "Buy America" provisions.

**Field Verification –** All materials permanently incorporated into a contract shall be field verified and documented by the Design Build inspector. The field verification or visual inspection shall occur prior to or during initial placement of materials. Field verification documentation should contain sufficient information to identify what was used including quantities. The field verification documentation needs to be initialed or signed and dated by the inspector at the time of verification. The field verification information should be the link between what was placed and paid for to what was specified by the Engineer of Record or approved on the RAM or QPL and its proper acceptance criteria.

**WSDOT Oversight –** The Design Builder shall distribute copies of all approval and acceptance documents to the WSDOT for their use. These documents need to be distributed to the WSDOT in a timely manner. The WSDOT will use these documents to verify what materials are being used in the project.

**Discussion**

WSDOT requirements developed under federal regulations require that a final materials certification be submitted to the FHWA Division Manager. This program allows for the Design Builder to approve their materials for use. With this materials documentation, we have some confidence that the Design Builders approval and acceptance procedures have been performed correctly.

# Design Build
# 31.00
# Materials Documentation Reviews

## Policy

The Design Builder shall make regular documentation reviews to ensure that all materials documentation and certifications are complete prior to the material being installed. WSDOT project office personnel will audit the Design Builders documentation reviews for conformance to the contract provisions.

WSDOT will perform formal materials documentation reviews at approximately 25% and 75% completion of construction. Items to be reviewed are randomly selected by the documentation reviewer. These reviews are to ensure the Design-Builder is maintaining all the necessary materials documentation and records. A separate review will be performed at the completion of the project to review all materials documentation.

In addition to the formal reviews, WSDOT on-site personnel will perform materials documentation checks. Examples of these checks include materials approval, materials acceptance, and field verification that the approved material was placed.

The Design-Builder shall submit a final materials certification package to WSDOT. This package shall include the materials checklist found in the Construction Manual, and all necessary supporting documentation. This documentation shall consist of a summary of all documentation practices utilized for material acceptance and an explanation of any deficiencies noted on the checklist. The summary should be organized in the order similar to Division 9 of the Standard Specifications for Road, Bridge, and Municipal Construction.

The Design-Builder will also submit to WSDOT the final materials records, temporary final records, and Final Record Book 1 as defined in Chapter 10-3 of the Construction Manual. The temporary final records are comprised of all relevant materials records not included in the final records. Copies of these records must be submitted to WSDOT to be retained for a 7-year period following acceptance of the project as required by RCW 40.14. All of these records shall be submitted to WSDOT within 90 days of physical completion.

## Discussion

These documentation reviews are being performed to ensure the Design-Builder is maintaining all the necessary materials documentation and records. WSDOT requirements developed under federal regulations require that for each project a materials certification is prepared at the end of projects and is submitted to the FHWA Division Administrator.

# Design Build
# 33.00
# Construction QA Manager

## Policy

The Design Builder shall have a Construction QA Manager on the project. The Construction QA Manager is a professional civil engineer, licensed in the state of Washington. The Construction QA Manager will not work under the direction of the Construction Superintendent and should report directly to the Project Manager. The Construction QA Manager shall be responsible for all materials approvals. The Quality Assurance testing laboratory will work under the direction of the Construction QA Manager.

The Construction QA Manager will be required to certify that all materials sampling and testing is in conformance with the contract requirements, and the "approved for construction" plans and specifications.

For any materials that are not covered by the WSDOT Construction Manual, the Materials Manuals, or in accordance with WSDOT/Design Builder agreement, the Construction QA Manager shall submit, with the concurrence of the Quality Assurance Team, specifications, including testing attributes, frequencies, and specification limits for the materials.

The Design-Builder's Construction QA Manager shall submit a final materials certification package to WSDOT, which contains a checklist and supporting documentation. The Design-Builder may use DOT form 350-115, Contract Materials Checklist or develop one of its own with the same information. The supporting documentation shall consist of a summary of all documentation practices utilized for material acceptance and explanations of any deficiencies noted on the checklist. The summary should be organized in the order similar to Division 9 of the Standard Specifications for Road, Bridge, and Municipal Construction.

## Discussion

This allows the Design Builder to approve their materials for use. Having one person in charge of approving all materials, assures WSDOT that the materials will meet the designer intent.

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# Design Build
# 40.00
# Materials Fabrication Inspection Program

**Policy**

**Fabrication Inspection**
The Design Builder is responsible for the QA inspection and approval of project specific fabricated items. The QA Fabrication inspector's will work under the direction of the Construction QA Manager. WSDOT will manage the Quality Verification (QV) of the fabrication items. The Design Builder will promptly notify WSDOT of the intended fabricator, fabricator inspector, and provide a copy of the "Approved" Shop Drawings. The Design Builder's fabrication inspector(s) shall provide a certification of compliance as appropriate for the type of material being inspected, and Stamp or Tag each approved item similar to the WSDOT requirements in section 9-1.5D of the Construction Manual.

The fabrication inspectors that are responsible for acceptance of structural steel shall be qualified as follows:

1. The Inspector shall be an AWS Certified Welding Inspector (CWI) qualified and certified in accordance with the provisions of AWS QCI, Standards for Qualification and Certification of Welding Inspectors,

2. or, the Inspector shall be qualified by the Canadian Welding Bureau (CWB) to the requirements of the Canadian Standard Association (CSA) standard W178.2, Certification of Welding Inspectors, level II or the level III requirements.

3. and, the inspector shall, prior to performing any inspections, have documented training on all applicable codes and specifications applicable to this specific project for the inspections to be performed. This training shall include evidence that the inspector is competent with the project specific specifications and requirements.

The fabricated items to be inspected include but are not limited to the following:

1. Treated timber and lumber except guardrail post and blocks
2. Treated piling
3. Epoxy coated rebar
4. Anchor bolts shipment
5. Type 1 raised pavement markers
6. Bridge bearings
7. Miscellaneous items that are shop welded
8. Miscellaneous galvanized steel items
9. Concrete and metal culvert pipe over 700 mm (27 inches) in diameter
10. Precast concrete panels
11. Prestressed concrete girders
12. Permanent precast concrete median barrier
13. Steel for bridges
14. Traffic signal and illumination standards
15. Utility vaults
16. Metal drainage castings
17. Precast Concrete Catch Basins, Manholes and Inlets. This includes all sections and risers 6 inch and above
18. Three sided Structures
19. Metal Bridge Rail
20. Sign Mounting Hardware

# Design Build
# 41.00
# Portland Cement Concrete and Hot Mix Asphalt Mix Designs

**Policy**

The Design Builder, or their designee, shall develop the concrete mix design per the standard specifications. The Design Builder's Construction QA Manager will certify that the concrete mix design conforms to the contract provisions and the Standard Specifications.

The concrete batch plant that the Design Builder uses for the production of Portland cement concrete shall be a National Ready Mix Concrete Association (NRMCA) approved plant.

The Design Builder, or their designee, shall develop the HMA mix design. They will determine the gradation, asphalt content, and anti-strip requirement according to the Standard Operating Procedure 732 in the Materials Manual. The Design Builder's Construction QA Manager shall certify that the HMA mix design meets all of the requirements of the contract provisions and the Standard Specifications.

The asphalt concrete plant(s) that the Design-Builder uses for the production of asphalt concrete shall meet all of the requirements as specified in the Standard Specifications. The Design-Builder's QA shall inspect the asphalt concrete plant(s) and document that it meets all requirements.

The Design Builder shall send a copy of the completed HMA mix design showing all trial blends and calculations, along with a sufficient amount of prepared aggregate for the Department to verify the adequacy of the proposed design. The verification effort by the Department will consist of mixing, at the determined asphalt content, eight (8) samples for checking the Air Voids , the Stripping requirements, and the Compactive effort. The use of the verified or non-verified HMA mix design shall be in accordance with WSDOT Standard Specifications.

**Discussion**

These are the same requirements that the department requires on WSDOT conventional projects.

# Design Build
# 42.00
# State Inspected and Tested Items

**Policy**

There are certain items that WSDOT has determined to be critical to the everyday operations of the roadway. These items would be inspected and tested by state forces to ensure that they meet state and federal requirements. These items include:

- Highway Traffic Signs: All traffic signs will be inspected at the point of fabrication by WSDOT. All signs so inspected will be tagged by the WSDOT Fabrication inspector prior to shipment with a Sign Acceptance report sent to the Design Builder.

- Traffic Signal Controllers: All traffic signal controllers will be tested by WSDOT in accordance with WSDOT SOP 429. The Design-Builder is advised that the time necessary to test a controller is dependent upon the quality of the product submitted and the response time of the vendor in correcting deficiencies in the programming or circuitry. Typically it will take approximately 2 weeks for testing if everything is correct. Only controllers tested by WSDOT shall be installed.

- ITS Systems: All ITS systems will be tested by WSDOT according to the requirements stated in the RFP.

- The RFP should include a Region/Local agency specific description of the equipment requirements for any ITS systems including traffic signal controller assembly included in the project. The information that needs to be provided is the type of controller (NEMA, 170E, 2070, etc.), the Software to be used, and the type of cabinet enclosure.

**Discussion**

These items are critical for traffic safety and need to be functioning correctly to avoid loss of life or property.

Design Build
43.00
Materials Standards

## Policy

The Design Builder's Construction Documents shall define the project requirements using WSDOT standards, contract documents, references and publications.  The following general regulations, references, and publications supplement the preceding references and those specifically referenced in the RFP  and shall be selected by the Design-Builder, as appropriate, to control the work described in the Contract Provisions. Inquiries concerning inconsistencies and conflicts shall be directed to the WSDOT Project Engineer.

The following WSDOT and AASHTO Publications shall be included in the Design Build agreement and followed for the acceptance of materials.

- Construction Manual (M47-01)
- Standard Specifications for Road, Bridge, and Municipal Construction (M41-10),
- AASHTO - Standard Specifications for Highways and Bridges
- Materials Manual (M46-01)
- Qualified Product List

## Discussion

WSDOT has  put a lot of effort in our manuals to include what works for us in our state; these should be carried out for all Design Build contracts.

If we don't define our requirements we could end up with materials and processes that we know don't work in our state and that could become maintenance problems.

# DESIGN-BUILD
# 50.00
# PAVEMENT WARRANTIES

## Policy

The Design-Builder shall be responsible for the pavement performance and warranty work for a period of five years following final acceptance of the project. The parameters to be used to evaluate pavement performance include: pavement ride quality, pavement friction, and pavement surface condition. These parameters will be measured and evaluated by the WSDOT HQ Materials – Pavements Division on an as needed basis (requested by the WSDOT Project Office) during the warranty period. The following outlines the threshold criteria for the pavement warranty at the end of the five-year warranty period

Hot-Mix Asphalt Pavements

- Ride quality (IRI): < 90 inches per mile
- Friction: > 40
- Pavement surface condition:
  - Rutting: < ¼ inch average, no individual 100 lane-foot section greater than ⅜inch.
  - Alligator cracking: < ¼ inch in width and < 0.1 percent of total pavement surface area
  - Longitudinal cracking: < ¼ inch in width and < 1 percent of the project length
  - Transverse cracking: < ¼ inch in width and < 1 crack per 2000 lane-feet
  - Systematic Density defects: 0% detected

Portland Cement Concrete Pavements

- Ride quality (IRI): < 90 inches per mile
- Friction: > 40
- Pavement surface condition:
  - Wear: < ⅛ inch
  - Cracking: one crack per panel and < 0.1 percent of panels
  - Faulting: none
  - Joint seal damage: < 2 percent of joint length per lane mile

## Discussion

The use of a pavement performance warranty provides WSDOT with a measure for evaluating the Design-Builder's construction quality. Though the above distress do not constitute all of the measures used to evaluate pavement performance, measurement of these distress are a good indication of overall pavement performance.

A draw back with the pavement warranty is that bonding agents have difficulty in providing bonding longer than five years. If a pavement is not placed properly, more than likely it will be noticeable within this five-year period; however, a five-year warranty does not necessarily imply a long-lived pavement life.

# DESIGN-BUILD
# 50.01
# PAVEMENT WARRANTIES TYPE - Policy

On design-bid-build (DBB) projects, WSDOT is responsible for the structural design of the pavement, the mix design of the pavement and the acceptance testing of the pavement. At each step, the WSDOT exerts direct control, and maintains responsibility, to obtain satisfactory results: durable pavements that meet the needs of the traveling public. WSDOT has been extremely effective in doing this with the DBB program, the early pavement failures are rare and pavement performance is generally exceptional. As we move into design-build, much of this control disappears and is turned over to the design-builder. As the control moves to the design-builder, so should the responsibility. There are two cases for warranties, full depth new pavement and overlays.

**Full depth new pavement:**
The design-builder (DB) has total control over three vital areas of building a quality pavement:

- Structural Design
- Mix design
- Quality Assurance/Quality Acceptance

The DB is instructed what standards to use when designing the structural design (i.e., the AASHTO 1993 Design Guide for Pavements), but many design decisions and parameters are fully under the DB control. Note that this is true, regardless of pavement type. The DB also decides on the mix design, regardless of pavement type, either using the Superpave © mix design protocol for Hot Mix Asphalt (HMA) or their own concrete mix design, for Portland Cement Concrete (PCC). Finally, although the state will perform verification testing, the DB will own both QC testing and QA testing.

Is it possible to build a new pavement, either in HMA or PCC, following the 1993 AASHTO Design Guide, using Superpave © or concrete mix designs and performing QC and QA testing and still have it fail early? Absolutely: early rutting failures, early flushing, smoothness failures, , friction failures, and systematic density defects are all possible with HMA and early cracking failures, smoothness failures and early wearing failures are all possible with PCC. Even with quality verification testing, QV, these early failures can still occur.

Warranties of short duration (3-5 years) provide the owner with protection against these early failures, failures that often tend to be catastrophic in nature, requiring early replacement. Contractors, or DBs, accurately and successfully price and estimate work where all the factors of success are under their control. When factors are outside their control, they will be inclined to price the risk they do not control, resulting in a greater “insurance” cost to the owner. Early use of warranties with inexperienced DBs may result in some extra “insurance” costs, as the DB prices a risk for which they are unfamiliar. More experienced DBs will understand that the risk of early failure is fully under their control for new, full depth pavements and will bid little to no extra "insurance" cost. This is a direct performance specification, rewarding DBs that know they can perform and penalizing those firms uncertain about their quality system plans.

## HMA Overlays

HMA overlays provide a slightly different case than full depth new pavement, since the DB firm is building on an existing HMA base over which they have little to no control. HMA overlays require different warranty considerations: only those factors, which are fully under the DB control, should remain in the warranty performance specifications.

Warranty performance specification for HMA overlays would include friction, rutting and systematic density defects. Warranty performance specifications outside the DB control would be eliminated from the warranty: alligator cracking, longitudinal cracking and transverse cracking. Smoothness may or may not be appropriate given the condition of the existing pavement, and would need to be evaluated on a project basis. Projects with sound existing pavement would have smoothness as part of the HMA warranty, those with extensive transverse cracking, with underlying PCC, may have smoothness excluded from the warranty provisions.

Warranties of 3-5 years are appropriate for HMA overlays.

## Materials and Workmanship Warranties

Materials and workmanship warranties are commonly used in business, far more common than performance warranties. Materials and Workmanship warranties in essence warrant that the project was built to the owner's specifications. Most owners use "method specifications" in conjunction with Materials and Workmanship warranties, wherein they tell the contractor how to construct an item of work. Materials and Workmanship warranties in turn warrant that the contractor has followed the owner's method specification, using the method required by the owner to construct the work.

In order for an owner to make a claim against this warranty, the owner must prove that while performing the construction, the contractor failed to follow the owner's method specification. Given the temporal nature of method specifications, there is often little data to show just how the contractor performed the work during construction. After all, one of the points of having a warranty is being able to avoid having to "hand-hold" the contractor, monitoring every little step of the construction. However, without such detailed records, and without notice to the contractor while they are performing the work as to the failures to follow the method specifications, there is little chance of enforcing the warranty. Further, not only do you have to prove that the contractor failed to follow the method specification, but you have to prove that the resulting failure is due to the failure to follow the method specification. Perhaps this is why Materials and Workmanship warranties are so often offered and so seldom enforced.

## Performance Warranties

Performance warranties differ substantially from Materials and Workmanship warranties. Performance warranties typically allow the contractor (design-builder) to choose their own methods, instead measuring the performance of the final product over a set period of time. How the DB gets the final product is not as important as actually getting the required performance. The owner established the performance measures and the performance criteria and also establishes the time frame over which they are to apply. The DB then chooses methods they deem appropriate to achieve the desired performance characteristics.

Performance warranties are the preferred warranty type for design-build projects.

# DESIGN-BUILD
# 50.10
# PAVEMENT TYPE SELECTION

## Policy

Pavement type selection will be in accordance with the *WSDOT Pavement Type Selection Protocol*.

## Discussion

Different pavement types offer different levels of service to the traveling public. Pavement type, for example, affects maintenance repair cycles, future rehabilitation cycles, and the number of days for roadway closure due to repair and rehabilitation.

WSDOT makes the pavement type selection determination. As the unbiased party when it comes to placement of a bituminous surface treatment, a hot mix asphalt pavement, or concrete pavement, the "owner's right to choose" is critical in obtaining the anticipated pavement performance life. The analysis for pavement type selection is conducted by the Region offices, in accordance with the *WSDOT Pavement Type Selection Protocol*, and is reviewed by the Pavement Type Selection Committee to ensure quality and policy compliance.

# DESIGN-BUILD
# 50.20
# DOWEL BAR TYPE SELECTION

## Policy

Stainless steel (clad, or hollow) dowel bars shall be used at all transverse joints in Portland cement concrete pavements.

## Discussion

Through coordination with the state DOT's of California and Minnesota, WSDOT has determined that the use of epoxy coated steel dowel bars in new construction of concrete pavements does not provide the desired pavement performance life of 50 or more years. Minnesota DOT has conducted a study of in-service concrete pavements that were constructed with epoxy coated steel dowel bars at transverse joints and has determined that significant corrosion has occurred in the dowel bars. The result of this study has indicated that the corrosion of epoxy coated dowel bars results in a pavement life of less than 20 years (dowel bar corrosion leads to joint deterioration which requires complete replacement of the concrete pavement). California DOT is currently conducting a study on the corrosion rates of a variety of different dowel bars (epoxy coated, stainless steel and stainless steel clad) and is finding that the epoxy coated bars are failing the corrosion testing, while the stainless steel bars are experiencing no corrosion. Therefore, WSDOT is recommending the use of stainless steel clad dowel bars on all newly constructed concrete pavements (modifications to the standard plan will hopefully be completed by the end of the year). These dowel bars are to be placed as designated in Standard Plan A-1.

Until recently there has only been one supplier of stainless steel clad dowel bars (Stelax). Stelax, since the bars are being shipped from Wales, has had delivery delays. However, Stelax is in the process of selecting a processing plant in the United States, which will greatly improve product delivery. In addition, a second company (SMI) is also trying to compete in the stainless steel clad market, but to date has had some manufacturing difficulties.

# DESIGN-BUILD
# 50.30
# QUALITY OF DOWEL BAR INSTALLATION

**Policy**

Dowel bar alignment shall be initially validated on pavement produced using production equipment by coring or other destructive testing process. Once dowel bar alignment has been verified and is within specification, dowel alignment may be verified through the use of the MIT Scan or equivalent device (accuracy of device must be confirmed through coring). Dowel bar alignment tolerances are listed in Standard Specification 5-05.3(10). In addition, dowel bars shall be free of surface irregularities or any signs of corrosion.

**Discussion**

To obtain long-lived concrete pavements (50+ years) that exhibit minimal future rehabilitation, dowel bar alignment must be held to tight tolerances. An improperly placed dowel bar will increase the pavement stress, which leads to cracking and eventual failure of the transverse joint or cement concrete panel. Improperly placed dowel bars have resulted in cement concrete pavement failure within the first five years.

Stainless steel clad dowel bars shall be free of all defects, including the condition of the coating. A bar that is corroded prior to placement will continue to corrode and not provide the desired pavement performance life.

# DESIGN-BUILD
# 60.00
# Geotechnical Baseline Report

**Policy**

**Definition**
A Geotechnical Baseline Report (GBR) is a document provided to bidders of design-build projects that summarizes the factual geotechnical data for a project and provides a framework or basis for interpretation of that data. The GBR should contain a collection of all the geotechnical data (e.g., boring logs, laboratory test data, geophysical data, field test results, geological field reconnaissance observations, rock slope mapping, etc.) available within the project limits. The geotechnical engineer or engineering geologist who develops the GBR should perform the geological interpretation necessary to accurately portray the subsurface conditions, and evaluate the geotechnical feasibility of the proposed design/construction project features. An important aspect of the GBR is an assessment of how the geotechnical conditions may affect the design and constructability of the project elements. This assessment is necessary so that potential bidders can better define risk during the bidding process.

## 60.10 Policy – Field Investigation Requirements for the GBR

The level of geotechnical field investigation necessary for preparation of the GBR shall be determined or approved by the State Geotechnical Engineer. The State Geotechnical Engineer and Region/Headquarters management will review and agree upon the short-term and long-term project performance risks when determining the initial level of investigation required and whenever field findings significantly alter those risks. The level of geotechnical investigation shall consider the amount of information necessary to reduce project bid costs. The amount of geotechnical investigation needed will be project specific, and shall be determined based on the guidelines provided herein

> *Note: Let's think about this in a more general nature: what if we had perfect site characterization for every DB project? Would this be a detriment for the DB firm? Would it limit their design choices? Or would it only eliminate bad design choices based upon incomplete data?*

The goals of the typical geotechnical investigation for design-build projects are to:

- Identify the soil and rock types within the project limits and assess how the material properties will affect the design and construction of the project elements.
- Define the ground water and surface water regimes. Especially, the depth and variability of groundwater or surface water within the project limits. The locations of confined water bearing zones, artesian pressures, and seasonal or tidal variations should also be identified.
- Identify and characterize any geologic hazards that may be present within or adjacent to the project limits (e.g., landslides, rockfall, debris flows, liquefaction, soft ground or otherwise unstable soils, seismic hazards, etc.).

- Assess the feasibility of the proposed alignments, including the feasibility and conceptual evaluation of retaining walls and slope angles for cuts and fills.
- Assess the feasibility of infiltration or detention facilities that may be needed, as well as provide conceptual recommendations for pond slope angle and infiltration rates to enable the Design Builder to estimate the approximate size and number of those facilities required for the project.
- Identify potential usability of on-site materials as fill, and/or the usability of nearby materials sources.
- For structures including bridges and cut-and cover tunnels, large culverts, signs, signals, luminaires, walls, or similar structures, provide adequate subsurface information for the design-builder to estimate foundation types and costs.
- For project that may include tunnels, trenchless technology, or ground improvement, provide adequate information to assess the feasibility of various construction methods and potential impacts to adjacent facilities.
- For projects that may include landslides, rockfall areas, and debris flows, provide adequate information to evaluate the feasibility of various stabilization or containment techniques.

To accomplish these goals, the typical geotechnical investigation should consist of the following:

- A review of historical records of previous investigations and construction of existing facilities.
- Review of land use records or reports that describe previous site uses, especially those that could identify the potential for hazardous waste.
- A geological site reconnaissance of the proposed alignment, focusing on all key project features, and identification of potential hazards within and adjacent to the alignment.
- A subsurface investigation consisting of an appropriate combination of borings, cone probes, field testing, field instrumentation (such as piezometers or inclinometers), and geophysical surveys.

As a starting point, utilize existing subsurface information from records and augment that information with additional borings, cone probes and/or geophysical surveys to fill in gaps in the existing information. Borings or cone probes should be spaced as discussed below.

It should be recognized that at the time of the field exploration many of the features investigated may not be defined. The geotechnical engineer or engineering geologist developing the GBR will have to utilize professional judgment to assess what project elements may need to be investigated and where they will likely be located in order to perform an adequate field investigation.

Where specific structure or other project feature locations (including infiltration facilities) are known with certainty, the design-builder may have no option to relocate or resize the structure. In this case, the field investigation program for the GBR should be extended to include all borings needed to meet state and national standards for final geotechnical design of the structure(s) or other features, at the state's discretion.

For cuts and fills, test borings should be advanced every 500 to 1,000 ft along the project alignment where cuts or fills are anticipated. For large cuts or fills (e.g., 30 ft or more in height) an additional borings near the top of the proposed cut or toe of the proposed fill to evaluate cut/fill feasibility and overall stability may be necessary. Depths of the borings should be at least twice the vertical height of the fill and at least 10 ft below the base of the cut. If soft/poor soils are encountered, additional depth will be needed to define the subsurface conditions.

For bridges and cut-and-cover tunnels, borings should be completed at each abutment, or portal, and at least every 300 to 500 ft of structure length for longer bridges and cut-and-cover tunnels. Borings for structures should be a minimum of 50 feet in length unless rock or other very dense material is encountered. If rock is encountered, the rock should be cored for at least 10 feet. For structures founded on piles or shafts, a good rule of thumb is to obtain at least 30 feet of soil that has a standard penetration resistance of 30 blows/ft or more.

For noise walls or retaining walls, at least one boring per wall should be completed at the most likely wall face location. Walls longer than 300 feet should have additional borings spaced every 300 ft to 500 ft. For taller retaining walls (e.g., 30 to 40 ft or more in height), or retaining walls that may be soil nail or tie-back walls, borings should be completed behind the wall to evaluate overall stability and ground anchor feasibility. The spacing on these borings should be twice the spacing of the borings along the wall face. The depth of borings for noise walls should be a minimum of 20 feet. Borings for retaining walls in fill situations should extend below the ground surface at least twice the wall height. Borings for retaining walls in cut situations should extend below the ground surface at least three times the exposed height of the wall.

For infiltration or detention facilities, at least one boring per site should be obtained to assess feasibility and define groundwater conditions. Boring depths will depend on the nature of the subsurface conditions encountered and the depth of influence of the geotechnical feature. Borings should extend at least 20 feet below the likely base elevation of the facility, or five times the maximum anticipated ponded water depth, whichever is greater. It is desirable to install piezometers and monitor them for at least one year prior to advertisement to assess yearly high and lows for the groundwater.

> *Note: Due to the accelerated nature of the work, the DB often will not have the time in the design phase of the project to monitor even one yearly cycle of ground water fluctuation, making it imperative that the owner do this work.*

For landslides or unstable areas multiple borings will likely be required as well as a detailed field mapping. As a minimum, at least two borings will be required, and instrumented with an inclinometer and a piezometer. Additional borings may be needed to define failure planes, stratigraphy, and groundwater. Boring depths will vary.

Greater boring spacing than those described above may be feasible provided the geotechnical site reconnaissance and the known site geology indicate that high quality soils are present and that conditions are fairly uniform and predictable within the project limits. If subsurface conditions are observed to be erratic based on the available data and site observations or if higher risk conditions are identified (see below), closer boring spacing may be needed to better define the extent of the specific condition of concern (e.g., soft soil deposits, liquefiable deposits, etc.). Geophysical methods can be used to supplement the borings and reduce the number of borings required.

Risks to be considered that could require a more detailed investigation than what may be considered typical shall include, but not be limited to, the following:

- liquefiable soils,
- very soft soils,
- areas of previous or potential instability (e.g., landslides, rockfall, severe erosion, etc.),
- rockslopes, and
- high groundwater.

The degree of investigation necessary to mitigate these risks will depend on the nature of the risk, the amount of detailed geotechnical information needed to mitigate that risk, and the impact such risks have on the potential project costs. A 50% to 80% level of geotechnical investigation to address these high-risk issues may need to be conducted to provide an adequate basis for bidding (see discussion below). To determine the amount of additional investigation required for these high-risk issues for a GBR level of investigation, the impact of such conditions on the ability of bidders to adequately estimate project costs and project staging/schedule shall be considered.

## 60.20 Policy – Level of Geotechnical Design and GBR Contents in Consideration of Risk Mitigation

All factual data obtained to develop the GBR (e.g., boring logs, geophysical test results, field test results, laboratory test results) shall be included in the GBR. Boring logs should be plotted on a project profile and/or cross-sections of specific project elements. Interpolation between borings to develop stratigraphy should not be done at this stage as borings are likely not spaced close enough to accurately define the stratigraphy. It is likely that the design-builder will obtain additional borings during design that can be used to define the stratigraphy. The GBR may need to provide an interpretive tie between the borings and the site geological interpretation of the soils and rock strata encountered. This interpretation is required to identify potential geological hazards not specifically encountered in the borings, but that are nevertheless likely to be encountered based on the general soil and rock types encountered in the borings, probes, or geophysical surveys. As such, the GBR should provide a summary of the regional and site geology for the project, as well as an evaluation of seismicity at the site.

If there is potential for soil liquefaction at the site, a preliminary assessment of the depth and extent of the liquefiable soils should be identified. A preliminary assessment of the feasibility of potential mitigation schemes may also be required, as well as an assessment of the impact of liquefaction on the proposed project features, depending on the impact to project feasibility.

*Note: we assess the potential for liquefaction in our soil structure characterization efforts and we conceptually address mitigation schemes if not addressing them could affect project feasibility.*

A characterization of the on-site materials as fill should also be made. A preliminary assessment of feasible cut and fill slopes should also be made to assess right-of-way needs and/or the need for retaining walls. Broad guidance on the feasibility of various wall types should also be provided. For structures, an assessment of the foundation types that are or are not feasible should also be provided

> *Note: On cut/fill slopes, we determine feasible slopes, or if walls are needed, feasible walls, to assess right-of-way needs. It is unreasonable to expect the design-builder to assess right-of-way needs due to the length of time it takes to get ROW secured, or if we do not get the needed ROW, to force the contractor to bid a much higher price because many more expensive retaining structures are needed to stay within current ROW. It would be most cost effective if the State determines, through a feasibility analysis of the slopes needed, what ROW is needed to keep project costs at a reasonable level. For structures, we only want to identify what foundation types we do not want the design-builder to consider. Very little design effort would normally be required to make this assessment.*

For ground water treatment, the geotechnical feasibility of proposed treatment strategies (e.g., infiltration ponds, detention facilities, etc.) should be assessed. This geotechnical feasibility includes assessing the effect of ground water and soil type on infiltration, stability of the facility, and the ability to construct the facility.

> *Note: Since infiltration facilities often impact ROW needs as well as permits, the feasibility of infiltration or other facilities as affected by ground water level, instability above or below the site, etc., must be assessed prior to RFP advertisement. This is only a go/no-go assessment.*

Any key constructability issues that need attention during the bidding process for constructing cuts and fills, especially construction staging and schedule issues, settlement, and stability concerns, for installing structure foundations, or to install walls (especially cut walls such as soil nail or tieback walls) should be identified.

## 60.30 Policy – Geotechnical Investigation During RFP Advertisement

Often with design build, specific project elements cannot be reasonably defined at the time the GBR and RFD are produced. To help minimize contingency costs in the bids and limit risk, it may be desirable to perform supplemental geotechnical investigations during the RFP process to augment the GBR. Whether or not supplemental geotechnical investigations should be completed during the RFP process is determined by mutual agreement between the State Geotechnical Engineer and Region/Headquarters management prior to advertisement of the RFP. Should supplemental investigation occur, the short-listed bidders should submit requests for additional information including locations and depths of borings. The State will evaluate the requests and develop an exploration program that eliminates duplication of borings in specific locations, eliminating potential conflicts between bidders, unwanted congestion due to the presence of multiple sets of drilling rigs and multiple crews, and to reduce costs through elimination of duplicated efforts. An example supplementary boring program is provided in Appendix A.

## Discussion

The amount of investigation required is highly dependent on the uniformity and predictability of the site conditions, the impact those conditions may have on the cost to construct the project, the risk associated with those conditions, and the overall size and complexity of the project. The description of the "typical" investigation program provided above should only be used as a starting point for developing the investigation plan for a design-build project. The high-risk issues identified in "Policy – Field Investigation Requirements" will generally require a more thorough investigation. For example, evaluation of liquefaction and the degree of mitigation required are strongly dependent on the specific soil gradation and layering present. Such details can affect the type of mitigation that is feasible, possibly doubling or even quadrupling the mitigation costs, and in addition affecting the foundation type(s) that are feasible and their associated costs. The nature of any very soft soils present can affect the cost of mitigation required, and affect where fills can be used in lieu of expensive structures. Soft soils can also affect the performance and rideability of pavements, and the degree and cost of mitigation required in this case, as well as construction staging and schedule impacts, can vary widely from minimal over-excavation to more expensive soil improvement strategies (to improve settlement, slope stability, or both), to long construction delays to wait out the settlement and/or improve stability. Areas of previous or potential instability can affect the feasibility of a given alignment (i.e., there may not be room available to fit in the mitigation solution needed), or possibly require the use of very expensive structural solutions (e.g., cylinder pile or tieback walls). The cost to stabilize an existing or new rock slope is highly dependent on the geologic structure of the rock mass, requiring the rock mass structure to be well defined to provide an adequate basis for bidding. If the rockslope cannot be stabilized, there must be adequate room to capture the rocks before they reach the transportation facility, also affecting feasibility. The presence of high ground water, in consideration of seasonal variations, can affect the feasibility of infiltration and even detention facilities, and minor differences in soil gradation can cause infiltration facility sizes to vary by an order of magnitude. This issue can affect environmental permitting as well. The presence of groundwater can affect certain types of construction, such as tunneling, pipe jacking, shaft foundations, as well as affect their feasibility.

Regarding cost and risk of cost overruns, enough geotechnical data and analysis must be provided so that the design-builder has a reasonably clear picture of the subsurface conditions and the effect of those conditions have on constructability and the total cost of what is to be constructed. Poorly defined conditions can result in wide swings in the cost of the design solutions needed, resulting in the need for more definition and impact assessment. This is especially critical regarding the high-risk issues described above. The investigation is too detailed, however, if subsurface explorations are conducted in locations where the subsurface conditions will have little or no impact on the project design and resulting construction cost.

The same philosophy applies to geotechnical analysis and design. The focus of any geotechnical analysis or design conducted in support of the GBR must be to evaluate feasibility only, and to reduce the potential for bidders to have wide swings in their estimate of project costs. For example, if shafts or piles are proposed as foundations for a bridge, the specific foundation loads will not be known accurately enough during GBR and RFP development to determine foundation depths and sizes. Therefore, detailed analysis of foundation skin friction and end bearing resistance would be of little use. The design-builder would have to redo such calculations during final design anyway. What is of more use is whether or not shaft or pile foundations are feasible to install, considering impacts to adjacent facilities, ability for equipment of sufficient size to access potential pier locations, etc. Enough information must be provided to bidders so that they can determine what foundation types are feasible.

Since the geotechnical investigation at time of bidding is generally inadequate to complete the final design, it would be risky for the State to provide a detailed stratigraphy of the subsurface conditions. In general, interpolation between borings should not be conducted prior to bidding. Geotechnical data at this stage should be presented with a minimum of interpretation, though, if geological interpretation of the conditions encountered would indicate that geotechnical hazards not specifically encountered in the borings should be anticipated (e.g., potential boulders, liquefiable soil, unstable conditions, earthquake faults, etc.), such hazards should be identified as likely to be encountered at the site. If geological interpretations must be provided to identify the potential for encountering such hazards, the report must be clear that these are interpretations.

# 60.40
# Appendix A

Example Supplemental Geotechnical Boring Program Provisions

In order to aid the Proposers in partially fulfilling these responsibilities, WSDOT plans to provide an opportunity for each Proposer to obtain additional geotechnical information at WSDOT's expense pursuant to Section 1-02.4(2) below. The Department makes no representation as to whether said Supplemental Boring Program will be sufficient for the Proposer to discharge its responsibilities set forth in the preceding paragraph. Each Proposer must make this determination independently based upon its own independent judgment and experience.

Because the geotechnical information necessary for each Proposer varies with each Proposer's design, it is recognized that the subsurface information provided with the Request for Best and Final Proposal may not provide all the geotechnical information that the Proposer may determine is necessary. Therefore, WSDOT will provide at its own cost additional geotechnical investigation as directed by the Proposers, subject to the limitations as provided herein, to be known as the "Supplemental Boring Program".

The Proposer is responsible for submitting to the Engineer, in writing, a Boring Program detailing the location (by station and offset) and highest bottom elevation of their requested borings by October 19, 2000. Late submittals will not be accepted. Failure to submit such a Boring Program by said date will constitute a conclusive presumption that the Proposer has determined that it does not require any additional geotechnical data to properly design, construct and price the work or that the Proposer intends to obtain such data at its expense. Each Proposer may submit up to three (3) boring locations. WSDOT will make every effort to locate the borings where requested. The borings will be performed at the locations requested, except that proposed boring locations within 20 feet of another will be averaged to one proposed location. If a Proposer's boring is averaged with another Proposer's boring, neither Proposer will be allowed an additional boring. Soon after October 26, 2000, the locations of all borings will be distributed to all Proposers in writing. Whether or not the Proposer’s requested borings were located exactly where requested, the requirements of Section 1-02.4(1) will still apply.

WSDOT in-house staff or an independent, qualified, drilling contractor will perform the Supplemental Boring Program. A qualified inspector working for WSDOT will inspect the borings. Survey personnel provided by WSDOT will establish boring locations and elevations. At the option of the Proposer, the Proposer may have a maximum of one on-site person to witness the drilling, sampling, testing and coring. All such on-site persons shall not interfere with the operation of the drillers and inspector, and shall coordinate transportation to the drilling site with WSDOT.

The WSDOT drill crew or drilling contractor will be prepared to conduct the following sampling and testing procedures in the 2000 Supplemental Boring Program: split-spoon samples and Standard Penetration Tests at five foot intervals and every change in stratum, minimum NQ-size rock cores, minimum ten foot rock cores with

RQD; field vane shear tests in soft clays; electronic cone penetrometer testing, conventional laboratory classification testing on disturbed soil samples; conventional laboratory tests on rock samples. The Proposer is responsible for including in its Boring Program submittal: the frequency and depth of field vane tests, the locations of split spoon samples and SPT tests, and the length and diameter of rock cores. Furthermore, the Proposer is responsible for including in its Boring Program submittal the depth of disturbed samples, undisturbed samples, and rock cores that they wish to obtain, and the corresponding tests to be conducted.

The State will perform the test borings in the order of its choice. Mobilization will take place on or about October 26, 2000. The Supplemental Boring Program Report, containing the final boring logs and laboratory test results, will be shared with all Proposers on or about November 27, 2000. Soil and rock samples that are not consumed by testing will be stored for inspection by the Proposers at the WSDOT Materials Laboratory. To examine these samples, refer to Section 1-03.4(2). Furthermore, all of the samples not consumed by testing, including disturbed samples, undisturbed samples, and rock cores, will be turned over to the Design-Builder immediately after the contract is awarded.